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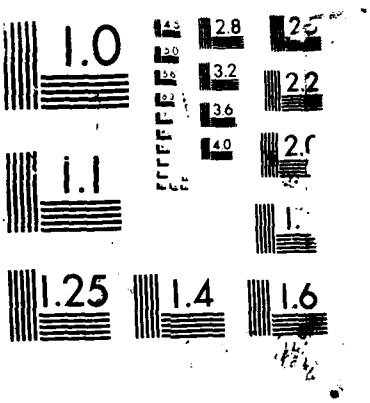
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Terms of Productivity, Including the Relationship Between Productivity, Effectiveness & Efficiency

April 1989

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Background

For some time now top government officials have realized that business-as-usual is no longer acceptable. In this time, of reducing resources and increasing demand, productivity would have to be improved. The Japanese have been providing a guiding beacon and demonstrating that the management theories Americans developed in the '40s and '50s can work.

Purpose

This paper provides some terms and concepts associated with productivity improvement efforts. Its purpose is to provide a common vocabulary.

Acknowledgements

Three people deserve special mention. Sandra Young provided the section on "Total Quality Management." Donald Addison provided the section on "Employee Participation Groups" Irvin Koch provided the section on "Unit Costing." I want to thank those who patiently reviewed drafts of this paper and provided valuable comments: Kurt Molholm, Betty Fox, Richard Evans, and Irvin Koch. Any errors in this paper are solely my own.

Reaching a Goal

Usually the following steps need to be taken for any goal to be reached:

1. Set the goal
2. Identify the current situation
3. Develop a plan to move from the current situation to the goal

(There are usually a series of feedback loops to ensure that, theoretically, the plan will move the organization from its current position to the goal.)

4. Implement the plan

The implementation is constantly monitored (measured for efficiency and effectiveness) and the plan or the goal is modified to insure congruence.

The goals, current situation, and plan must be made known to those whose actions are needed for successful implementation. Ideally, this would be everyone who could affect the process.

Venn Diagram of Data

Raw data must be converted into information before a rational decision can be made. For a decision to be made there must be at least two alternatives (maintaining the status quo is an alternative).

> [Often when there are only two alternatives presented there is a tendency to "dress-up" one of the alternatives. To make one look so appealing when compared to the other that there is no real choice for the decision maker. Which alternative is "dressed-up" depends on whether the presenter wants change or is satisfied with the current situation. The presenter must refrain from this tendency by giving each alternative

fair representation. Quite often this means requiring at least three alternatives be presented. It is also important that discarded alternatives be identified, first, so that the analysis is shown to be thorough, second so that effort in alternative analysis won't be duplicated.]

There is a large universe of data in existence; however, it probably does not contain all of the data that we need (represented by the "Data Needed" oval extending beyond the "Universe of Data"). We also receive more data than we need (represented by the "Data Received" oval extending beyond the "Data Needed" oval). [See Figure 1]

Venn Diagram of Data

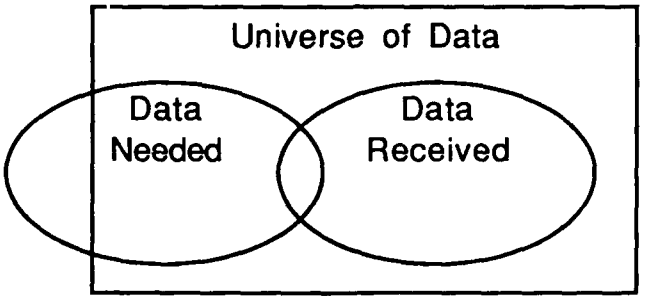


Figure 1

One of our goals could be to increase the area of intersection. Another goal might be to expand the "Universe of Data" to encompass more of the "Data Needed" oval. And probably a third goal would be to reduce the "Data Received" oval portion that is not intersecting with the "Data Needed" oval. The result might be as shown in Figure 2.

Venn Diagram of Data

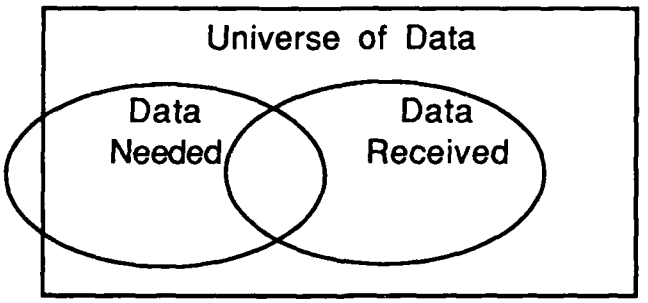


Figure 2

Useful information comes from adequately processing the raw data shown in the intersecting area of "Data Needed" and "Data Received".

Efficiency Versus Effectiveness

(This section is based on a lecture given by the author to a class on basic supervision in 1980, at the US Army Garrison-Yongsan in Seoul, Korea. Figure 3 was developed at that time.)

Efficiency

Efficiency is measured by output-input ratios. For example, widgets produced compared to the labor-hours expended to produce them. Labor-hours expended as the denominator in the following equation may be replaced by any other measure of input, such as, dollars expended, square feet used, or value of equipment.

$$\text{Efficiency} = \frac{\text{widgets produced}}{\text{labor-hours expended}}$$

The above formula is a simple one. It is certainly possible to develop more complex formulas. Efficiency needs to be measured over time to see if the correct trend is developing. Most often the desired trend is toward increasing efficiency. If efficiency is not being measured then several negative trends could develop, such as requiring more resources to be expended to get the same output or no improvement in productivity over the years. The measurement of efficiency assumes that quality remains constant.

Effectiveness

Effectiveness is measured by actual output-desired output ratios. For example, actual widgets produced compared to the programmed number of widgets that should be produced, as is demonstrated in the following equation.

$$\text{Effectiveness} = \frac{\text{actual widgets produced}}{\text{program widgets to be produced}}$$

Effectiveness needs to be measured over time to see if the correct trend is developing. Most often the desired trend is toward increasing effectiveness. If effectiveness is not being measured then the negative trend of constantly failing to meet the objective could develop.

It is also valuable to distinguish between operational effectiveness and mission effectiveness. Operational effectiveness looks inward. The above formula is an example of a measure of operational effectiveness. It is more concrete and concerns goals the organization has established for itself. It is usually much easier to measure than is mission effectiveness. Mission effectiveness looks outward. It is concerned with identifying customer goals and seeing how close the organization comes to fulfilling those goals. Mission effectiveness is the more important of the two.

It is possible to be very effective but not efficient, and vice versa. Normally effectiveness is more critical than efficiency since to be ineffective means that the goal was not accomplished, whereas to be inefficient means that resources were wasted but the goal might still have been accomplished.

At each level of the organization, or for each machine (or group of machines), or each process (or groups of processes) a measure of efficiency and a measure of effectiveness can be established. (Actually, several measures of each may be used at each level.) The

closer to the overall system level one gets, the more critical the measures become. The relationship between efficiency and effectiveness is illustrated in Figure 3.

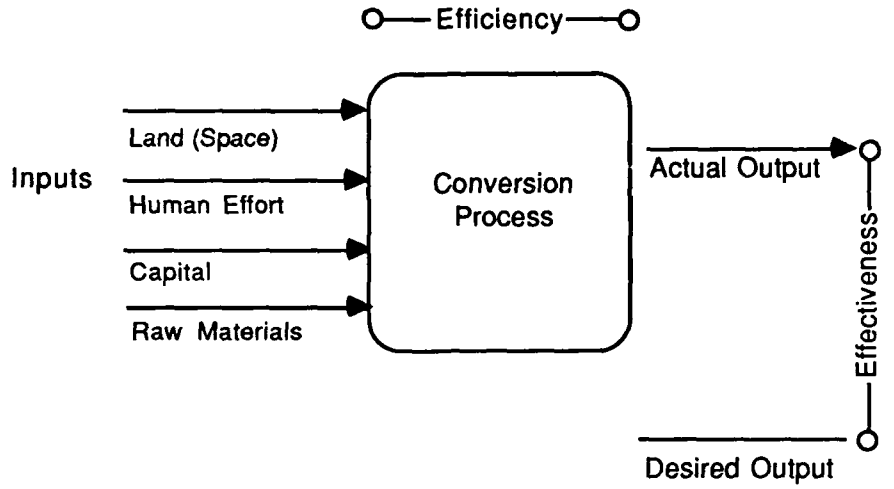


Figure 3

Productivity

Productivity is measured by combining measures of efficiency and measures of effectiveness. One way of stating this might be to say that productivity is the ability to achieve desired results with the least cost. The effectiveness part is "the ability to achieve desired results"; the efficiency part is "with the least cost."

Total Quality Management

This section on Total Quality Management (TQM) was prepare by Sandra Young.

TQM is the Department of Defense (DoD) strategy for continuously improving performance at every level and in all areas of responsibility. The objective is continuous improvement of processes, with emphasis on preventing defects rather than discovering them through product inspection. TQM focuses on the processes---the systematic approaches to accomplishing specific tasks--that create products and services. The activities are ultimately focused on increased customer/user satisfaction. To restate, TQM strategy is doing the right thing, right the first time; always striving for improvement, and always satisfying the customer.

TQM is not just another buzz word nor is it a program. It is a change in the way we think and the way we deal with people. TQM is DTIC's methodology for providing the leadership, training, and motivation to continuously improve our management and operations.

To be successful, everyone at DTIC must be a part of the TQM effort. The TQM Steering Committee reports to the Administrator, is chaired by the Deputy Administrator and all Directorate Chiefs and Chiefs of Separate Offices are members. The steering committee develops TQM philosophy and policy, develops the plan for TQM implementation, provides resource support for TQM activities and identifies and prioritizes initial projects. The involvement of top management and the incorporation of TQM into DTIC strategic planning will insure continuity of TQM initiatives.

Basic to the concept of TQM is the belief that employees have the greatest knowledge of the processes with which they are involved. Positive process improvement will primarily be generated from the ideas of those who participate in the process. Employees will be encouraged to be creative and to make decisions within their areas of expertise. Supervisors will no longer rely on authoritarian techniques, but will assume the role of team leader. Every individual will be involved in improving his or her own work processes. This participative management style will create the new, more flexible environment and culture required to encourage and accept change.

Process analysis will be carried out by Process Action Teams (PATs). The teams are formed by representatives of each work area involved in a process. PATs differ from Quality Circles in several ways. They are established by management. Members are appointed based on their knowledge of the problem and participation may require up to 30% of their time.

The PAT analysis method has seven steps:

Select the process
Establish the boundaries of the process
Define the process
Identify the internal and external customers
Identify customer requirements
Compare requirements with the process
Redesign the process

PAT team members will be trained in TQM methodology, problem solving techniques and statistical analysis tools.

Achieving TQM will not happen overnight. It will take a great deal of discipline to work on TQM day after day until it becomes a way of life; our way of doing business.

Statistical Process Control

The techniques of Statistical Process Control (SPC) come under the broader category of Total Quality Control (TQC) or Total Quality Management (TQM).

The idea behind SPC is to have a method of providing the right information to the right person at the right time so that a correct decision can be made. In practice, statistical data is fed back to an operator so that corrections can be made to keep a process in control and reduce waste.

The following must be present for SPC to work:

Right Information - This is information developed from accurate data that has been properly analyzed. The method of data collection and analysis must be kept as simple as possible.

Right Person - This normally is the person actually doing the work (or directly responsible for the work), or the immediate supervisor of the person doing the work.

Right Time - Information must be timely. Information provided too late for action to be taken is worthless information.

If any of these three are not present then any resources devoted to the effort have been wasted and a decision based upon sound reasoning cannot be made.

SPC lends itself to areas where there are large numbers of units that can be counted, and the count can be fed back quickly enough so that changes can be made to the process. It is not as easily applied where the measures of efficiency and effectiveness are not quantitative or the feedback is not timely. One of the tools used in SPC is the control chart.

Control Charts

A control chart shows when a process is in or out of control.

The control chart needs to be carefully constructed and tailored to the situation if it is to provide valuable information. Control charts are generally broken down into two categories: those that measure attributes (discrete data) and those that measure variables (continuous data).

Control charts for attributes deal with such items as pass/fail, or the number of rejects. The number of rejects (np) chart is a common attribute control chart. Control charts for variables deal with measurements, such as inches or pounds. The X-Bar and Range charts are common variable control charts.

Process Trend

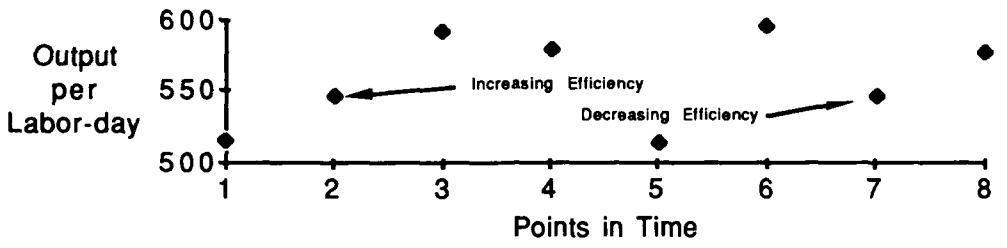
The type of chart or table that is envisioned as being most applicable to the Defense Technical Information Center (DTIC), especially at any level above the individual machine, is one which does not use upper and lower control limits but one which demonstrates changes in efficiency or effectiveness by showing actual performance over time. With this type of chart the objective is not to investigate out-of-control conditions, but to identify when the process was not improved upon. Management would then look into the reasons why the process was not improved upon. I refer to this type of chart as a "Process Trend Chart."

The Process Trend table or chart does not tell you if the conversion process is in or out of control like a control chart would. However, it does show you if you are improving or declining in efficiency or effectiveness (depending on what you have chosen to measure) as compared to what your performance has been. This table or chart would be applicable to many processes. It is easy to use and understand. It helps in "managing by exception." The mathematics involved are minimal and the process trend can be interpreted at a glance. Shown below is an example.

Process Trend Table

Output/Labor-Day
516
546
591
579
513
595
546
576

Process Trend Chart



Cause & Effect Diagrams

A cause & effect diagram is a very powerful tool for dealing with problems. Many textbooks will deal with their common use; however, the C&E diagram can be expanded to contain all of the elements needed to solve major problems. Following are the steps that can be used to do this.

Identify the Effect/Problem.

Sketch out a cause & effect diagram.

Assign percentages to the major components (If necessary using forced comparison techniques, etc.)(This actually combines the cause & effect diagram with the Pareto principle.)

Target in on major percentage items with new cause & effect diagrams.

Assign percentages to the major components.

Continue the iterations until specific effects/problems are broken down to manageable components; and solutions/alternatives become intuitively obvious.

Add cost analysis to the solutions/alternatives.

Recognize that there are two different types of cost: the cost to correct the problem, and the cost the problem causes. The cost the problem causes can be included right on the diagram. Putting the solutions/alternatives and the resulting economic analysis on the diagram will probably be awkward and should probably be done separately.

Employee Participation Groups

This section on employee participation groups was prepared by Donald Addison.

Quality Circles

Quality Circles are an effective and proven means for people to assume greater responsibility for their work environment and provide new leadership resources for an organization to build on.

The definition of a Quality Circle can vary according to the needs of the organization. The traditional circle is made up of five to ten people who form a common bond of work experience and can directly influence daily operations. The people may be from the same work area, cross organization elements, or cross hierarchical levels. They should meet on a voluntary basis to identify, analyze, and solve problems or to recommend possible solutions to management.

Members are trained in problem solving techniques such as: problem identification, cause and effect analysis, information sorting, force field analysis, brainstorming and data gathering. The techniques members learn help build confidence and self esteem to promote an environment where employees assume greater responsibility for their jobs.

A successful Quality Circle program should have its goals and objectives linked to those of the organization. A serious program begins with a serious commitment from top level management to a new approach of solving problems within an organization.

The structure of a Quality Circle starts with a Steering Committee that is usually made up of: top level management, a Program Coordinator, and rotating circle members. The Steering Committee: supports, advises, makes policy, and acts as a resource for the Quality Circle program. The next level in the QC structure is the Program Coordinator, who administers the QC program by reporting circle progress and problems to the Steering Committee. The Program Coordinator also trains facilitators and circle leaders. Another level is the Circle Facilitator, who has the responsibility of training Circle Leaders, helping plan circle activities, and providing liaison between management and circle members. The next level is the Circle Leader, who manages circle meetings, encourages participation, and trains circle members.

DTIC has taken a positive approach toward participative management by establishing a Quality Circle program as a response to the rapidly changing conditions in the Federal Government. DTIC conducted an analysis of employee involvement programs and concluded that employees are more willing to work hard and contribute ideas for improvement if they have input into decisions affecting their immediate work environment. Since its inception in 1981, Quality Circles have made several improvements in the areas of communication, production, quality awareness, employee development skills and leadership capabilities. Also, cost saving benefits have been recognized by the agency due to the program's on-going success. DTIC has found an avenue to capitalize on the synergism which flows through the promotion of a team approach. Quality Circles participation at DTIC is approximately 20 percent of the work force, with nine active and two inactive circles.

Task Teams

Another form of employee participation group is the task team. Task teams are usually formed at the request of management to address specific problems. Members of task

teams are usually selected by management because of the diverse skills needed to solve complex problems that cut across departmental lines. Task teams are unique in composition and function when compared with other employee participation groups. They act as a ready reserve group that may be activated when needed and disbanded when the mission is completed. This type of employee participation group has not been greatly used at DTIC.

Unit Costing for DTIC

This section on unit costing was prepared by Irvin Koch.

DLA is changing its method of managing activities. Under the previous method, resources were managed based upon past funding levels with incremental changes for anticipated changes in activity. Under the method to be formally introduced starting 1 Oct 89, DLA will manage resources on a per unit basis. That is, DTIC's cost for producing a unit will be determined, a forecast of the units that we will need to produce will be prepared, and DTIC will manage the funds to cover that level of production.

DTIC could be defined as the following 30 products and services:

TR Collection	WUIS Collection	IR&D Collection
PEDS Collection	TR Output HC	TR Output MF
TRAC	CAB	TR Bibs
ADD	IR&D Output	WUIS Output
PEDS Output	Mag Tape Dist	SBIR (TIPs)
Reference Svcs	In-house Pubs	DROLS
DGIS & GENIUS	SearchMAESTRO	Registration Svcs
Info Sec Control	DLA Printing	MATRIS
Marketing, Field Svcs, etc.	Mgmt Svcs	Minor Missions
Other Work	IAC Support	R & D

A major effort at DTIC will be concerned with "cost allocation." That is, the assigning of costs to these 30 products. All costs not directly tied to the production of a unit are to be budgeted based on some relationship to the units. Thus the budget for most second and higher level supervisors/managers would be tied to their first line units produced, as would DTIC-L, R, W and much of DTIC-Z in almost all cases. Budget authority/control may be delegated to the lowest practical level. Management will be tied to the standard cost/hours per unit, given an efficiency target set by DTIC. The program also calls for being reimbursed for all work done for another DLA agency; and reimbursing all service given by other DLA agencies. (Charging DASC for the overhead on printing will be a major change.)

The program requires that all equipment over $10,000.00, except PCs, be depreciated. ADP equipment and software will be depreciated over 5 years and all else over 10 years. Work done to the facilities costing over $25,000 will be depreciated over 20 years. Our "cost of products" will be lowered by including only that year's depreciation (one fifth or one tenth of original cost in most cases). However, there may be an "investment" budget in addition to the "operating" budget mentioned so far. Also, our authority to obligate funds may be somewhat different from the budget for a given year depending on whether DLA has funds, and if equipment is actually purchased in a given year based on the accumulated depreciation.

There are other items being considered, such as employee incentive plans and success sharing.

Implementation will mean some extra ledgers for the DTIC Checkbook; placement of both the complete office (FDRB instead of just F, for example) and product/service code on all documents which result in a Checkbook entry; and the use of rules to allocate both labor and non-labor costs which must be split over more than one product/service equivalent.

Participative Management

Management theory has gone through many twists and turns over the past century. However, there have been basic changes in the work force. The population is better educated and informed. Basic survival needs have been satisfied. People are no longer thought of (and will not permit themselves to be thought of) as animals or machines to be plugged into a process.

We probably can agree on a few items without probing management theory too deeply. One, the person doing the job knows more about the specific job being done than does anyone else. Two, no one person knows everything. Three, anyone can have a good idea. Four, there is always a better way. If we accept these ideas then we can see the logic behind participative management.

Participative management does not mean that managers turn control of the organization over to the workers, or that workers have a veto over managers' actions, or that authoritarian management style is never used. Participative management just means that we involve the worker, where appropriate, in the decision making process. They may assume more authority, responsibility, and accountability as required by the situation.

Management theory would say that: where there is a long lead time, need for consensus, well informed employees and insufficient information held by the decision maker, have more participation; where there is a short lead time, little need for consensus, little specific knowledge held by the employees and enough information held by the decision maker, have less participation.

DTIC's general situation calls for more participation rather than less, as defined by the above paragraph.

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